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THE IMPACT OF DIFFERENT CHARACTERISTICS AND MODALITIES OF PHYSICAL ACTIVITY ON HEALTH VARIABLES IN ELDERLY PEOPLE WITH TYPE 2 DIABETES

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Abstract. *Type 2 diabetes (T2D) comprises 90 % of people with diabetes around the world, and is largely the result of excess body weight and physical inactivity (WHO, 2015).*
Objective: To evaluate and analyze evidence based research studies exploring the impact of physical activity on health variables in elderly population age 50-70 years with T2D.
Data sources: Web of Science, CINAHL, SCOPUS, EMBASE, MEDLINE, PubMed and SPORTdiscus data bases were used for screening and selecting relevant research studies over the period 2005-2015.
Study Selections: Randomized controlled trials (RCTs). Population: older adults or elderly with T2D. Intervention: All types of physical activity such as interval walking, aquatics or free living activity were included. Outcomes: glycemic control, lipid profile, insulin sensitivity, BMI, blood pressure and VO_2max. Methodological quality was assessed using the Delphi List.
Data Synthesis: While 1773 potentially relevant studies were found and 213 RCTs were relevant to the topic, only 16 studies (patients n = 946) accepted to the review.
Results: The circuit resistance training was associated with hemoglobin A1c (HbA1c) decrease (8.0 (.35) to 7.36 (.28)), body mass index (BMI) reduction from 22.0 (.8) to 20.9 (.8) and body weight change from 53.3 (1.6) to 51.9 (1.7). Improvement of insulin sensitivity, VO2max and glycemic control were observable in 8 studies including 16-week aerobic exercise training, 16-week interval walking training, and combined aerobic and resistance training. Combination of aerobic and resistance exercises were associated with positive change in plasma fasting glucose and were 6.86 (1.40) and 6.19 (1.47).
Conclusions: The most effective and time consuming physical activity is interval walking, circuit training or combination of different intensity and/or physical activity modalities.
Keywords: *health, physical activity, type 2 diabetes.*

Introduction

Type 2 diabetes mellitus (T2DM) is a rapidly growing disease worldwide (Beck – Nielsen et al., 2012). The increasing prevalence of obesity and sedentary lifestyle are the major underlying causes ranking T2DM as one of the

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fastest growing public health problems worldwide (Barengo et al., 2009). National diabetes prevalence is the 5th highest in the European Union according data from Portugal, Slovenia, Cyprus, and Lithuania (Dzerve et al., 2013). Exercise training provides a wealth of health, cardiovascular and metabolic benefits (Huffman et al., 2014; Schwingshackl et al., 2014). The effects of exercise on glycemic control in individuals with type 2 diabetes are well documented but the optimal exercise intensity and type remain to be defined (Kartsoft et al., 2014). Isolated effect of resistance, aerobic training or combination of both have been reviewed by Schwingshackl et al., (2014) and other authors. Moreover, Schwingshackl et al., (2014) focused only on glycemic control and blood lipids as study outcomes.

This study consists of a systematic review with meta-analysis of randomized controlled clinical trials (RCTs) presenting association of structured physical exercise training and physical activity, with various intensity and modality on glycemic control, physiological and on risk of obesity variables. The importance of physical activity for people with T2DM is obvious but there still lack of information about what type and intensity of physical activity can contribute more important health related outcomes for patients with T2DM.

The aim of the present study was evaluate and analyze evidence based research studies exploring the impact of physical activity on health variables in elderly population age 50-70 years with T2D.

Methods

The scientific literature search was performed using the electronic data bases Web of Science, CINAHL, SCOPUS, EMBASE, MEDLINE, PubMed, and SPORTdiscus. The search was restricted to the publications in English language from 2005 till 2015. Two independent reviewers extracted data and assessed quality of the included studies. The following keywords were used for relevant studies were‘exercise therapy’ or ‘free living activity’ or ‘interval training’ or ‘walking’ or ‘combined training’ or ‘adapted physical activity’ or ‘aquatic exercise’ AND ‘relieve symptoms’ or ‘improve functions’ or ‘rehabilitation’ or ‘glycemic control’ or ‘lipids’ or ‘VO² max’ or ‘HR’ or ‘insulin’ AND ‘type 2 diabetes’ or ‘T2DM’ or ‘metabolic syndrome’. The reference lists of all identified articles were screened for additional studies. Full-text articles were selected after the review of the titles and abstracts. Then full-text were screened for eligibility criteria and were included or excluded from the review.

Studies were included in the review if they met following criteria - a randomized controlled trial, control group or two intervention groups, patients with type 2 diabetes without secondary complications, BMI ≥ 30, mean age 50 and not younger than 45, at least one of the biochemical variable outcome (e.g. glycemic control, lipid profile, insulin sensitivity etc.), the reporting of the changes from baseline with SDs, published in English language, and the exclusion of articles with dietary mixed intervention. All abstracts and full texts were independently assessed for inclusion criteria by two independent investigators.

From 1773 potentially relevant citations retrieved from electronic databases and searches of reference lists, 16 RCTs met the inclusion criteria. A flow diagram of search and selection is shown in Fig. 1. The following data were extracted from each study: the first author's last name, publication year, study duration, participants age, gender, BMI, number of participants in each group, group assignment, content of the program, intensity of physical activity, treatment effects on biochemical and physiological outcomes.

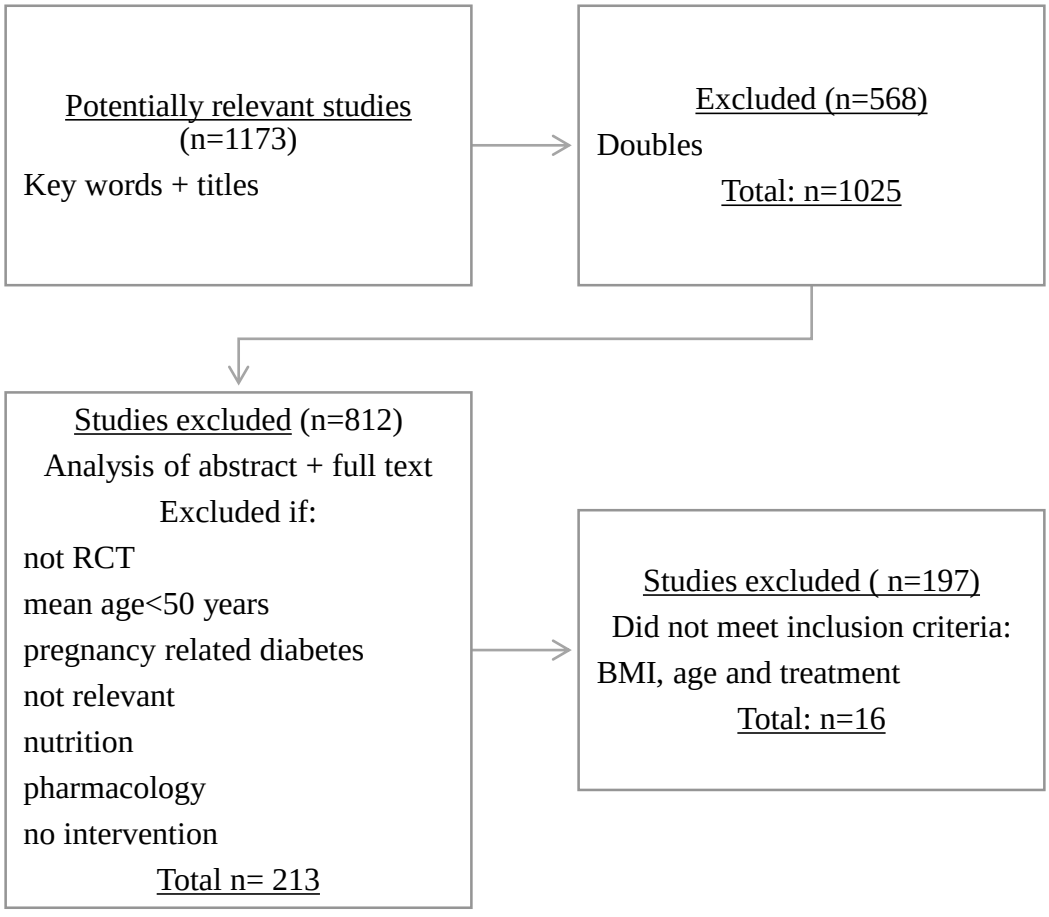

Figure 1 **Flow-chart: selection of studies**

Assessment of methodological quality

The methodological quality was assessed using the Delphi List for Quality Assessment of Randomized Clinical Trials and was performed by two reviewers. The scale gives each study a score from 0 to 9 with three answer options yes (1), no (0) and not reported (0). The included articles Delphi score was from 3 to 7. This was based on the fact that even low quality RCT's could provide some useful information. No articles were excluded because of low Delphi scores**.**

Results

Identified studies

The databases were searched and 1173 studies were selected according to their relevance to the topic. The titles of the articles were analyzed. The second screening was performed looking at the abstracts, doubles studies were excluded. Only 213 studies from 1025 were further retrieved and analyzed in full text. Total of 16 studies were included in this review (See figure 1). The characteristics of the included studies are shown in Table 1. The final 16 included studies had a total of 971 patients (64 % females). The participant's age range was from 46.6 till 74.90 years. Exercise program duration ranged from 8 to 96 weeks with a frequency of exercise ranging from one to seven days per week. Of those 946 patients 185 were included in aerobic exercise, 77 in yoga training, 66 in diaphragmatic breathing, 63 in resistance exercises training, 40 in interval training, and 29 in strength training. In addition, 39 participants participated in combined endurance and resistance training, 14 were in circuit training and only 8 subjects used vibration exercise training. Four studies were from Korea and fourteen from different countries from around the world. The study characteristics is shown in Table 1.

In the study by Bacchi et al., (2012), Choi et al., (2012) the physical activity in one of the intervention group was reported as aerobic exercise training. The study outcomes were HbA1c reduction (-0.40 (-0.61 to -0.10), 7.1 (6.8-7.6) to 6.9 (6.5-7.3) respectively). Mitranun et al., (2014) showed improvements in reducing HbA1c (60 ± 2 to 54 ± 2), however Karstoft et al., (2013) reported no change using interval training. The circuit resistance training was associated with hemoglobinA1c (HbA1c) decrease from 8.0 (±.35) to 7.36 (±.28), body mass index (BMI) reduction from 22.0 (±.8) to 20.9 (±.8) and body weight change from 53.3 (± 1.6) to 51.9 (± 1.7) kg (Kang et al., 2009). Combination of aerobic and resistance exercises were associated with positive change in plasma fasting glucose and were 6.86 (± 1.40) and 6.19 (± 1.47) (Tan et al., 2012). The study characteristics and outcomes is shown in Table 2.

Table 1 **Study characteristics**

Author, year	Age (SD)	N	Gender F/M	BMI (kg/m²)	Group assignment	Study frequency
Bacchi et al., (2012)	57.2(1.6) 55.6(1.7)	20 20	14/6 14/6	29.5(1.1) 29.2(1.0)	Aerobic Resistance	16w 3x60min
Baum et al., (2007)	63.3(5.9) 62.9(7.3) 62.2(4.0)	13 13 14	NR NR NR	29.4(4.2) 29.07(3.1) 26.49(6.3)	Flexibility Strength Vibration	12w 3x15min 12w 3x30-40min
Choi et al., (2012)	53.8 (7.2) 55.0 (6.0)	37 16	NR NR	26.8(2.4)	Endurance Control	12w 5x60min
Egger et al., (2012)	64.5(7.1) 65.2(8.6)	16 16	5/18 8/8	29.9(4.7) 29.8 (5.3)	Endurance Strength	8w 2x70min 8w 2x55min
Gordon et al., (2008)	64 63.9 63.6	77 77 77	62/16 62/15 62/15	27.35(0.51) 27.28(0.39)	Hatha yoga Standard Control	24w 1x 120min 24w 1x 120min
Hegde et al., (2012)	60.0(10.4) 57.5(8.9)	60 63	NR NR	24.9(3.1.) 25.3(3.9)	Breathing Control	12w 7x15-20
Kang et al., (2009)	50.4(2.14) 52.5(2.15)	7 8	NR NR	22.0(8) 23.6(1.4)	Circuit Walking	12w 3x60min 12w 3x60min
Han et al., (2010)	55.7(7.0) 55.7(6.2) 57.8(8.1)	15 13 16	NR NR NR	27.1(2.4) 27.1(2.3) 27.4(2.8)	Endurance Resistance Control	12w 5x60min 12w 5x60min
Kurban et al., (2011)	53.77(8.2) 53.57(6.6)	30 30	13/17 18/12	30.90(4.64) 30.23(4.74)	Walking Control	12w 3x50min
Loimaala et al., (2009)	53.6(6.2) 54.0(5.0)	24 24	NR NR	29.3(3.7) 29.8(3.6)	End+Resist Control	96w 4x30min
Meex et al ., (2010)	59.4(1.1) 59.0(0.8)	18 20	0/18 0/20	30.0(0.8) 29.7(0.8)	End+Resist Control	12w 3x45min
Mitranun et al., (2014)	61.7(2.7) 61.2 (2.8) 60.9(2.4)	14 14 15	9/5 9/5 10/5	29.4(0.7) 29.6(0.5) 29.7(0.4)	Continuous Interval Control	12w 3x30-40min 12w 3x30-40min
Sung et al., (2012)	70.2(4.7) 70.1 (3.6)	22 18	15/7 11/7	23.9 25.45	Walk+Edc Control	24w 3x50min
Karstoft et al., (2013)	60.8(2.2) 57.5(2.4) 57.1(3.0)	12 12 8	4/8 5/7 3/5	29.9(1.6) 29.0(1.3) 29.7(1.9)	Continuous Interval Control	16w 5x60min 16w 5x60min
Tan et al., (2012)	65.9(4.2) 64.8(6.8)	15 10	10/8 6/5	25.2(2.5) 25.8(2.5)	End+Resist Control	24w 3x50min
Ng et al., (2011)	57(7) 59(7)	30 30	19/11 22/8	27.4(4.7) 27.8(5.2)	Resistance Endurance	8w NRx50min 8w NRx50min

End+Resist – endurance and resistance training, Walk+Edc – walking training and education program, NR – not recorded.

Table 2 **Study characteristics and outcomes**

Author, year	Groups	Intensity	Biochemical outcomes	Physiological outcomes
Bacchi et al., (2012)	Aerobic Resistance	60-65% HRR 70-80% 1-RM	HbA1c insulin sensitivity,βcell f-n	$V0_2$max (A↑) strength↑(R)
Baum et al., (2007)	Flexibility Strength Vibration	 70-80% 1 RM 30-35Hz	OGTT(V,S↓) HbA1c(V↓)	m.quadriceps max isom.st.(S↑) HR(all↓)
Choi et al., (2012)	Endurance Control	Average		Weight↓,BP↓ VO_2max ↑
Egger et al., (2012)	Endurance Strength	 70% 1RM	GI (V,S↓)	Weight,BMI,HR S/D BP (E,S)
Gordon et al., (2008)	Hatha yoga Standard	 70% max	HbA1(Y), GI (Y,S)	Sys/Diast blood pressure (Y)
Hegde et al., (2012)	Breathing	NR	IFG (↓)HbA1(↓)	BMI (↓)
Kang et al., (2009)	Circuit Walking	60%max 60%max	HbA1(At)	Muscle mass(↑) BMI (↓)
Han et al., (2010)	Endurance Resistance	Average 40-50%max EC	Insulin sensitivity (no change)	BMI (↓)
Kurban et al., (2011)	Walking	Average	Antioksidation status	
Loimaala et al., (2009)	End+Resist	65-75% VO_2 max	Hemoglobin(↑), good for metabolic control	VO_2max (↑), m.strength(↑) BMI (↓)
Meex et al., (2010)	End+Resist	55%Wmax	Insulin sensitivity	
Mitranun et al., (2014)	Continuous Interval	50-60%, 80%+50% VO_2max	Insulin sensitivity (I,C),HbA1(I)	HR(I,C), leg m.strenght (I,C), VO_2max(I)
Sung et al., (2012)	Walk.+Edc	55-64;65-75% HRmax	HbA1	Everyday activity level
Karstoft et al., (2013)	Continuous Interval	55%max PEE 70%max PEE	Glucose(I)	VO_2max (I), BMI(I)
Tan et al., (2012)	End+Resist	55-70% PHRmax, 50-70% max1RM	Lipids profile	strength, obesity outcomes
Ng et al., (2011)	Resistance Endurance	65% 1RM 65%max HR		Mental health status

HRR - heart rate reserve, 1 - RM – one repetition maximum, BP – blood pressure, GI – glucose level, PEE – peak energy - expenditure rate, max EC – max of exercise capacity, PHRmax – predicted heart rate maximum, Wmax – workload maximum.

Discussion

According to this literature search this is the first review comparing the pooled effects of different type and modalities of physical activity on wide range of health related outcomes for elderly population without secondary health conditions, non-obese with type2 diabetes. The main interest of this review was to present the most effective, time consuming and also cost efficient physical activity programs applicable in Latvia. The result of the present study indicated that any type of properly organized physical activity contributes health variables of persons with T2DM. Also, it was found that articles from 2005-2010 mostly presented implementation of aerobic physical activity programs with the average intensity while only recent studies have focused on the interval training with higher intensity. Earlier interval training mostly was used for athletes and healthy population in comparison with the new studies were interval training used for cardiac and diabetic population. One of our interests was also free living activities such as walking. Walking as aerobic training has been used more frequently during the last decade. Kartsoft et al., (2013) showed that walking could be very powerful tool in the interval training format. Moreover, this approach is cost and time efficient.

In conclusion, any type of physical activity positively influence physiological and/or biochemical outcomes. However the most efficient and time consuming physical activity training is interval walking, circuit training or combination of different intensities or physical activity modalities.

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